

CITY OF BRYAN
WATER DISTRIBUTION SYSTEM
MASTER PLAN UPDATE
JULY 2007



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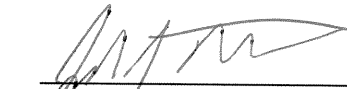
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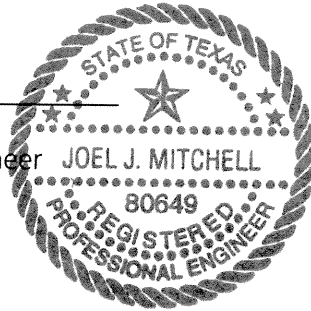


CERTIFICATION

I hereby certify that this work was completed under my supervision.



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Registered Professional Engineer
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City of Bryan 2006 Comprehensive Plan Water Distribution System Master Plan Update

Background

As part of the 2006 Comprehensive Plan the City of Bryan requested an update to the 2002 Water Distribution System Master Plan prepared by CDM Engineers. The scope of the update was to include the following:

- ❖ Add all major water lines to the model that have been constructed since the date of the original model
- ❖ Calibrate the model
- ❖ Review the priority list from 2002 and from the Production Master Plan and determine if the priorities are still valid, amend them if they are not and produce a new priority list, if applicable.
- ❖ Review the fire hydrant spacing as well as fire flow rates available throughout the City to assure adequate fire coverage to all parts of the City of Bryan. Any improvements needed should be outlined with costs and checked for constructability.
- ❖ Review the overall City water demands vs. water production to assure that the recommendations on water supply are still valid based upon current and future population. Consideration should be made for the location of the City's CCN's. Review and discussion regarding the Region G Water Plan should be included.

Task 1 - Addition of New Lines

The first task was to add all water lines that had been constructed between 2002 and October 2006. A listing of new lines constructed within this time frame was provided by the City of Bryan based upon construction drawings. It was from this data that these new lines were entered into the model.

The water model was originally prepared in "MikeNet", a program developed by the Danish Hydraulic Institute. This model utilizes a memory intensive graphical user interface with a wide array of features. Due to the memory requirements of MikeNet, it is slow in performing many simple tasks. EPANet, a freeware program, developed by the US-EPA uses the same modeling engine but without many of the bells and whistles. Because of this it runs more complex extended period simulations very quickly. A combination of the two programs was used to perform the analysis.

Task 2 – Model Calibration

While entering the data for the new water lines it became obvious that there were concerns with the modeling results being produced. Several system parameters suggested that model calibration would be essential to ensure the accuracy of the recommendations.

System Demand

Pumping data was used to determine the average and peak day water demand that should be placed on the system. Ten years of pumping data (1996-2006) (Appendix A-1 and A-2) was utilized to calculate the annual and daily water usage in the system. The data analyzed indicates an average daily water demand of 7,174 gallons per minute (10.33 million gallons per day) and an increase in water usage of 1.08% per year over the past ten years.

As expected, the pumping rates vary significantly during periods of hot dry weather as the residents of Bryan use water for irrigation. For the purpose of comparison, the daily water demand in January and February (winter) is indicative of the domestic flow (drinking, washing, flushing, etc), while the differential between the winter and summer flows is representative of the irrigation demand on the system. Using this concept, the average daily water use per Bryan resident is 111 gallons per day during January and February and 300 gallons per day during the hot dry summer months or roughly 200 gallons per person per day used for irrigation.

In an effort to quantify a per capita demand for the water system, historical water demands and population figures over the past 6 years were used which resulted in an average demand of approximately 150 gallons per person per day. (Appendix A-3).

System Growth

Utilizing historic data, water demand was projected by two methods. The first uses a medium population growth rate of 1.5%, while the other method uses a curve fit through the historical pumping data which resulted in an increase of annual water usage of 1.08% over the past ten years. These figures can be seen in Appendix A-4. Utilizing this data, the system water demand has been estimated through the year 2060. It is important to note that if Bryan begins to experience growth rates of 1.8-2% as seen in the past 20 years these water demand projections will be insufficient and must be modified.

In order to estimate the peak day and peak hour water demand rates the City of Bryan Water Department daily log books were utilized. Data from the months of August 06 (historically the highest use month) and June 06 (due to an early summer drought, the highest recorded daily pumping occurred on June 14, 2006) was tabulated. This included all high service

pumping and the water level in each of the three elevated water tanks. The pumping rates were adjusted to accommodate water entering and leaving the elevated water tanks to estimate the demand each hour. This resulted in a peak day estimate at twice the average daily demand or 14,348 gallons per minute (20.66 million gallons per day.) The peak hour estimate was three times the average daily demand or 21,522 gallons per minute (30.99 million gallons per day). Appendix A-5 and A-6 show the actual demands from June 06 and August 06 along with daily rainfall. It is interesting to note how significantly water usage is affected by rainfall. In all three rainfall events, the water demand was reduced in half during and immediately after the rain occurred.

Demand Distribution

Demands were distributed throughout the system using water meter data from the City of Bryan utility billing database. Each of the roughly 20,000 meters within the City was assigned an address and the water meter usage was assigned to the nearest (of over 2000) nodes within the model. This was accomplished using the ESRI Arc-View 9.0, add-in "Multiple Minimum Distance."

Node Elevations

Additionally, there were a number of problematic node elevations in the model so new elevations were assigned to each node using the 2002 aerial topography and ESRI Arc-View 9.0. The elevation assigned to each node was based upon the nearest topographic feature with an associated elevation (contour or spot-elevation.) The use of ground elevations for each node automatically creates an error of 1 psi in the pressure results because the field pressure is read on the fire hydrant located 3 feet above the ground. However, this assumption is typical in water modeling and this 1 psi difference is negligible in the overall system. The important consideration is to assure that the basis of the node elevations is consistently applied.

Fire Flow Tests

To begin the calibration process, the city water services department performed fire flow tests on sixty two (62) hydrants throughout the city and collected detailed data on the fire flow and the system conditions (pumping, tank levels) during the test. Appendix B-1 is a summary of the fire flow data collected. The system data (pumping, tank levels) from the water operator log books was also collected to calculate the system demand at the time of the flow tests. This data was compared to the flow test data as a back check to ensure the validity of the information collected and logged.

Model parameters were calculated and the model was calibrated to duplicate the system pumping and elevated storage tank elevation in each

of the sixty two tests. In keeping with published technical data regarding the use of pipe roughness coefficients, the static and residual pressures were computed using Hazen-Williams coefficients ranging from 80-100. The difference between the static and residual pressure on the static hydrant was chosen as the comparison parameter because it is not affected by elevation errors. The data from the trials is shown in Appendix B-1. Because water demand, pipe lengths, pipe diameters, and water distribution system geometry are essentially known parameters, the only variable adjusted in the calibration was the Hazen-Williams roughness coefficient. At the completion of the calibration effort, a roughness coefficient of 100 was used for all older pipes and 110-120 for newer pipes. These values are consistent with the technical literature for this parameter.

In order to further confirm the accuracy of the model, pressure contour maps were generated by testing each node individually under peak day conditions. Please see Exhibit 3 for the Pressure Contour Map for the City of Bryan CCN. This test was performed to determine the greatest fire flow attainable from that node without any node in the system falling below 20 psi. Pressure contours were generated on the entire data set from this process. This process revealed a significant number of unattached nodes in the model. All of the misconnected and unconnected pipes were identified, researched and resolved in the geometry of the system model.

Task 3 – Review 2002 Water Master Plan & Production Recommendations

The proposed capacity improvements itemized in the *2002 CDM Water Distribution System Master Plan* were reviewed and categorized into completed, not recommended, recommended with a priority and an alternate recommended with a priority. Several of the 2002 recommended projects have been completed while others are no longer necessary because of changed conditions. There were also two additional recommendations added to the list. All of the improvements, the new recommendations and their costs are tabulated in the Appendix C-1 and graphically on Exhibit 1 of this document. The numbering system used on these graphics corresponds to the numbering system used in the *2002 CDM Water Distribution System Master Plan* (WDSMP). In the 2002 WDSMP, improvements numbered 5.x-x were existing capacity improvements while those numbered 1 through 18 were system expansion improvements. The additional existing capacity improvement recommendations as part of this update are numbered Improvement M&M 1 and Improvement M&M 2, and the one additional system expansion improvement is identified as Improvement M&M A.

A. Completed Projects

The improvement list was reviewed by City of Bryan Water Department Personnel and all projects completed since the 2002 Master Plan were assigned a status of “completed” and removed from consideration.

B. Not Recommended - Changed Conditions - Service Area

The second category involved all projects that were no longer necessary. The projects which fit this category were caused by changed conditions. In 2002, the City of Bryan had an established CCN (Certificate of Convenience and Necessity) area where they were permitted to provide water service. The 2002 Master Plan showed that this service area had overlap as well as some unserved area when compared with adjacent special utility districts. The City of Bryan is currently working to resolve these areas through the CCN process and the planned CCN boundary is shown on Exhibit 1. The change between 2002 and 2006 in the CCN limits has eliminated the need for many of the 2002 Water Master Plan improvements.

C. Capacity Improvements

The improvements that were categorized in the 2002 Water Master Plan as capacity improvements were individually added to the model and tested for effectiveness. Because the new model created with this update reflects lower system losses and demand, some of these recommended improvements are now unnecessary because the existing system is sufficient. All of the improvements, the new recommendation and their costs are shown on Appendix C-1 and depicted graphically on Exhibit 1.

There were two recommendations that are still valid but only with modification.

Recommended with Modifications

No. 5.1-6

The most significant changes are in recommended improvement No. 5.1-6. This improvement consisted of all the following:

- 24-inch line from Boonville Road to FM 1179 along Hwy 6
- 18-inch line to FM 1179 from FM 158
- 18-inch line to Elevated Storage Tank
- One MG Elevated Storage Tank

The recommended location for this elevated storage tank was in an area now developed as the Miramont golf course. Extended period simulations were conducted at average day and peak day conditions using three different pumping schemes to estimate the effectiveness of the elevated storage tank. The three pumping schemes used were constant rate, demand rate, and demand rate lagged by one hour. In all cases, the

elevated storage tank operated at the bottom of the range. Appendix C-2 shows the operation of this elevated storage tank assuming peak day conditions with the system pumping lagging system demand by one hour. This condition was chosen because it is the current technique used in the operation of the system. Adjusting the location of the proposed elevated storage tank to the old Boonville Town site behind Tom Light Chevrolet and Atkinson Toyota slightly improves this operation and requires a fraction of the infrastructure to support its function (Appendix C-3).

No. 5.1-7

The other significant change from the proposed capacity improvements is in recommended improvement No. 5.1-7. This improvement consisted of the following:

- 24-inch line from Woodville Rd to Hwy 21 along Hwy 6

This 24-inch line improved the system capacity in north east Bryan and allowed the elevated storage tank on North Texas Avenue to function properly. This elevated storage has experienced problems with overflow because the location is not as hydraulically remote as the other two elevated storage locations. The interim solution used by operation personnel has been to close the 18-inch valve at Stevens Drive. While this does keep the tank from overflowing, it lowers the water level below the other two elevated storage tanks and creates a situation under peak day and peak hour conditions where the system pressures have to be raised to keep the tank in the operating range. This situation also increases pumping cost, but the increased cost is difficult to quantify. The modeling shows that the construction of the 24-inch line (and leaving the 18-inch valve at Stevens closed) would allow this elevated storage tank to operate exactly as the other two elevated storage tanks. However, the installation of an altitude valve would accomplish the same goal at a lower cost, and the 24-inch line could be reduced in size to an 18-inch line with significant savings to the city.

An 18-inch line along the east bypass will have a similar effect on the operation of the tank as the altitude valve by maintaining the 18" valve at Stevens in the closed position. Alternately, the altitude valve could be placed in the distribution system but the maintenance costs would be identical but controlling the water surface elevation in the tower would be more difficult and would required throttling valves in various locations around the tower.

D. System Expansion Improvements

In the 2002 Water Distribution System Master Plan there were also recommendations for improvements that would expand the water system into areas not currently served to support growth. These improvements

were also analyzed in the new model, additional demand added to the new area served and then tested for effectiveness. Note that a gross water demand of 1080 gpd/acre was assigned to all undeveloped areas as a conservative average daily demand within these future developed areas. Because of the changes to the CCN area, several of the recommended improvements were beyond the limits of the CCN. Many of these recommendations were affected by the change in service area and are discussed in detail below. These improvements are denoted as *Improvement No. X* on Exhibit 1.

Improvement No. 1: 12-inch Line in Hwy 21: This utility extension is proposed along this fairly undeveloped corridor into the city along SH 21 from SH 47 to FM 2818. This improvement will allow an area along SH 21 to develop and have adequate fire flow for small businesses and some residential development. The water service area along this corridor is very large and this 12-inch line will provide only a very small fraction of the water supply necessary to serve this large area. Because of the size, the proximity to the well field, and the significantly lower ground elevations, a separate pressure plane with pump stations, elevated storage, ground storage, and transmission mains may be a better solution for this area. This idea should be investigated before investing in upgrades to the existing system to serve this area.

Improvement No. 2: 12-inch Line along SH 47 from Leonard Road to SH 21: This waterline extension will allow an area along SH 47 to develop and have adequate fire flow. Ultimately, it may be more cost effective to serve this area with a separate pressure plan and its associated infrastructure rather than upgrade the existing system to serve it.

Improvement No. 3: 24-inch Line from FM 2818 to FM 1179:
Construction complete.

Improvement No. 4: 12-inch Line along Hwy 6 from Briarcrest to 29th Street: This utility extension will allow the west side of the East Bypass to develop. A portion of this improvement has already been constructed with development. A few parcels along this alignment are vacant, and completion of this work would encourage development along this major corridor. If the City desired to wait on these improvements, development will eventually construct the majority of them.

Improvement No. 5: 12-inch Line from Tabor Rd. to Old Reliance: The 2002 Water Master Plan shows this line well beyond the limits of the CCN. An alternate location for this line is shown on Exhibit 1.

Improvement No. 6: 12-inch Line in Old Reliance Road: This line was constructed for the new high school.

Improvement No. 7: 8-inch Loop from Mumford to Sandy Point: This area will be annexed in the near future and an 8-inch loop will not be sufficient to serve even modest growth of the area. Ultimately, this area will need to be served from all four directions and the 8-inch line replaced. This line should be constructed as a minimum 12-inch line so that it does not have to be replaced prematurely. An alternate alignment along Mumford Road towards SH 21 which ties into Sandy Point road would accomplish the same goal, and allow the southern portion of this area to also have water service.

Improvement No. 8: 18-inch Line in Leonard road to SH 47: This line has been constructed.

Improvement No. 9: 16-inch Loop from FM1179 to FM2818: This line has been partially completed with the Traditions Project and it provides an excellent supply for future development. Because this line will be served with the 12-inch line running to Gabbard Road it could be completed as a 12-inch rather than 16-inch line. This improvement should be completed with the roadway construction along the same alignment.

Improvement No. 10: 1.0 MG Elevated Storage Tank: This tank is proposed in the 2002 Water Master Plan off Leonard Road. The modeling shows that this location will have similar problems as the Miramont location and will operate at lower levels than the remainder of the system. This elevated storage tank would operate more effectively on a separate pressure plane as discussed in Improvement No. 1 above.

Improvement No. 11: 18-inch Line to Elevated Storage Tank: This improvement would be used to serve the 1.0 MG Elevated Storage Tank described in Improvement No. 10 above.

Improvement No. 12: 12-inch Line from Briarcrest and Hwy 6 to Copperfield Dr.: Recommended, see discussion in Improvement No. 4 above.

Improvement No. 13: 12-inch Line Hwy 158 to Back of Copperfield Subdivision: Recommended, see discussion in No. 5.1-6 above.

Improvement No. 14: 12-inch Line in Hwy 21: The area for this extension is beyond the CCN boundary, but the area is currently served with 6-inch and 8-inch lines which do not provide enough fire flow for

significant development. If the City of Bryan desired to encourage development along Hwy 21 the 12-inch waterline should be constructed.

Improvement No. 15: 12-inch Line in Future Roadway, between Hwy 21 & Austin's Colony: The route of this line is beyond the CCN boundary. This line is not recommended.

Improvement No. 16: 18-inch Loop in Woodville: The route of this line is beyond the CCN boundary. This line is not recommended.

Improvement No. 17: 16-inch Loop from Woodville to Tabor Road: The route of this line is at the CCN boundary. This line is not recommended.

Improvement No. 18: 12-inch Loop from 2818 to Woodville Road: The route of this line is beyond the CCN boundary. The alignment should be adjusted along the eastern right-of-way of SH6 and should be sized as an 18-inch line to serve ultimate development.

Improvement No. 19: 12-inch Line to OSR/D&S Water: This line will service the adjacent D&S special utility district. It does not appear that it will provide value to the City of Bryan, therefore it is not recommended.

Improvement No. 20: 12-inch Line in Sandy Point Road to D&S Water: This line will service the adjacent D&S special utility district. It does not appear that it will provide value to the City of Bryan, therefore it is not recommended.

Improvement No. 21: 12-inch Line in Northern Bryan: The route of this line is beyond the CCN boundary, therefore it is not recommended.

E. Additional Water Distribution System Recommendations Capacity Improvements

Improvement M&M 1: Pump for High Service Pump Station: TCEQ requires specific combinations of system pumping and elevated storage. Because of the amount of elevated storage in the Bryan system, the system must be able to pump the peak hour demand with the largest pump out of service. This will require a new pump be placed in service this year. A system curve is provided in Appendix C-4. Note that this system curve does not reflect any of the pumps in the system.

Improvement M&M 2: Elevation Valve for N. Texas 1 MG Elevated Storage Tank: See discussion above in 5.1-7.

System Expansion Improvements

Improvement M&M A: 18-inch Line along 2818 from SH 6 to SH 21:

Ultimate development will require an 18-inch line along the west side of FM2818 to service this area.

Task 4 - Review fire hydrant spacing and fire flow rates

Hydrant Spacing

Exhibit 2 illustrates the existing fire hydrants within the system. Using a maximum spacing of 300 feet for hydrants within commercially developed areas and a maximum spacing of 500 feet within residentially developed areas, a map was produced illustrating areas within the city that may not have adequate coverage. Some of the areas that show insufficient coverage may be vacant so each area should be reviewed independently for necessary improvements.

Fire Flows

Exhibit 1 illustrates nodes within the water system that produce fire flow rates within certain ranges. There are only 2 nodes within the system that currently cannot produce at least a 500 gpm fireflow and both of these locations are on 2-inch water lines. One of these fire flow problem areas will be corrected with a recommended waterline improvement project. The second location on SH 21 near SH6 should not be of concern since hydrants nearby are on larger lines that can produce a flowrate of more than 1500 gpm. The orange and blue triangle marked areas are those that should be examined closer to see if improvements may be required to provide adequate fire flow to existing homes and businesses.

Task 5 - Review water supply recommendations

There have been two water supply reports completed in the last 7 years for the City of Bryan. The first study was authored by Malcolm-Pirnie and entitled *City of Bryan Water Supply Study*. This study discussed the City's desire to increase pumping supply from 22.3 million gallons per day (mgd) firm capacity to 30 mgd. The recommended alternative was to add three new wells, each with a pumping capacity of 3.5 mgd (since the Malcolm-Pirnie report, two additional wells have been added to the system). Based upon Malcolm-Pirnie's report these recommended improvements will supply peak day demands through the year 2030.

The second report was prepared in 2006 by HDR Engineering. This study was titled the *2006 Brazos G Regional Water Plan*, and was the result of a statewide water study undertaken to compel communities to work together to solve water

supply problems. The report projected population, water use, and water availability for this region (37 counties) which was delineated roughly along the Brazos River Watershed Boundaries. Using available water supplies within the area, the report projected dates when communities would encounter insufficient water supply for their citizens and made recommendations to alleviate any future water shortages.

The Region G report estimated that the City of Bryan per capita demand is currently 147 gallons per person per day and by the year 2060 this demand would drop to 134 gallons per person per day. It is stated that this decrease is due to the requirement for water conservation plumbing fixtures in all new buildings. Population was also projected as 109,881 in 2060 for the City of Bryan. This report states that given the population and per capita water demand projections, the City of Bryan will need a water supply of 14.72 mgd in 2060 to serve its population. The Region G area is so large and many areas within that planning area do not have sufficient water supply to serve them, it appears they will be using the Carrizo-Wilcox aquifer as well. Although this aquifer has a capacity of 224 mgd and Bryan's projected need is only 14.72 mgd in 2060, additional users of this aquifer will result in the City of Bryan experiencing water shortages in 2050.

Population projections and forecasted water demands within the *2006 M&M Water Distribution System Master Plan Update* varies significantly from the Region G study. If the growth of Bryan is closer to a 1.5% growth rate, and water allocations are made out of the Carrizo-Wilcox for areas currently using the Edwards Aquifer and other water sources, there is the potential that the City of Bryan may begin to experience shortages as early as 2029, nearly 21 years earlier than the Region G report projected.

The Brazos Valley Groundwater Conservation District was created in 2001 to protect and conserve the groundwater resources of Brazos and Robertson Counties. However, several other groundwater districts compete for the available water in our aquifer. The future availability of water for the City of Bryan cannot be defined until legislation is written to establish the priorities for water allocations amongst these various groundwater districts. This legislative situation should be closely monitored and the City of Bryan should take a lead role in those legislative discussions to ensure an ample future water supply for continued growth.

Conclusion

The City of Bryan water model has now been updated and is ready for use. It will be important to assure a regular update process occurs to keep the model current. This will allow staff to utilize the model as a tool to analyze incoming development proposals as well as guide capital improvement projects. Annual

pumping data along with population numbers should be collected as they become available to calculate increased water demands on the system.

To date, the City of Bryan has completed approximately \$10.1 million in water improvements as recommended from the 2002 Water Distribution System Master Plan. Based upon updated recommendations contained herein, there is still approximately \$8.2 million of existing system capacity improvements and another \$21.9 million of system expansion improvements to accomplish.

It is important to note that this report does not address replacement of water lines due to maintenance issues. Large water lines that have sufficient capacity may need to be replaced due to the age and condition of these pipes. Additionally, the approximately 85 miles of two inch (2") waterlines within the existing system have reached their functional life expectancy and should be replaced. Assuming that these lines would be replaced with six inch (6") waterlines at a construction cost of \$55/LF, the cost for replacement of all these lines would be approximately \$24,684,000. It would be advantageous spread out the replacement of these lines over a five to ten year period due to the high cost of replacement of these lines at one time.

Based upon the existing water supply studies, once the Malcolm-Pirnie recommendations to add 3 wells has been completed, the City of Bryan will have sufficient pumping capacity to supply the City of Bryan through the year 2030.

According to the Region G report, the City of Bryan will have an adequate water supply through the year 2050. However, if a more moderate population growth rate of 1.5% per year occurs over the next 15 years, water supply shortages may be felt as early as 2029. As growth occurs, additional studies should be undertaken to ensure that water shortages do not occur sooner than anticipated.

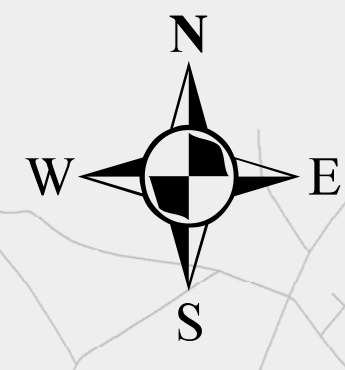


EXHIBIT 1

City of Bryan

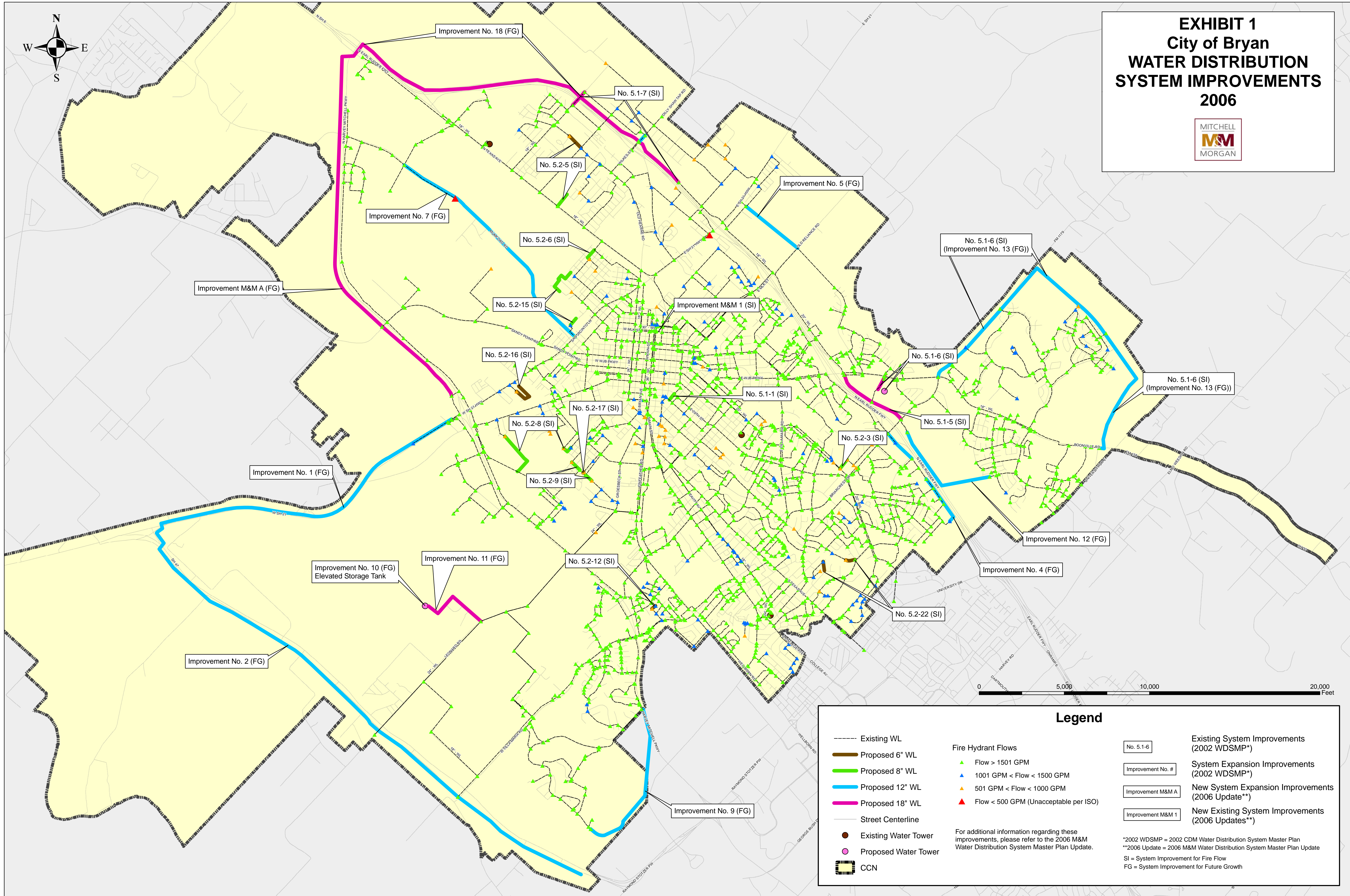
WATER DISTRIBUTION

SYSTEM IMPROVEMENTS

2006

MITCHELL

MORGAN



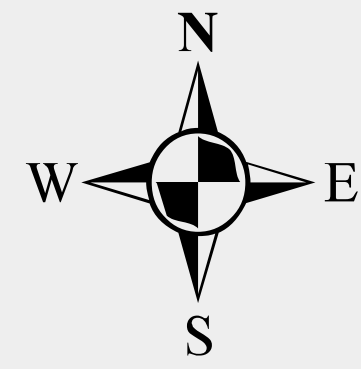
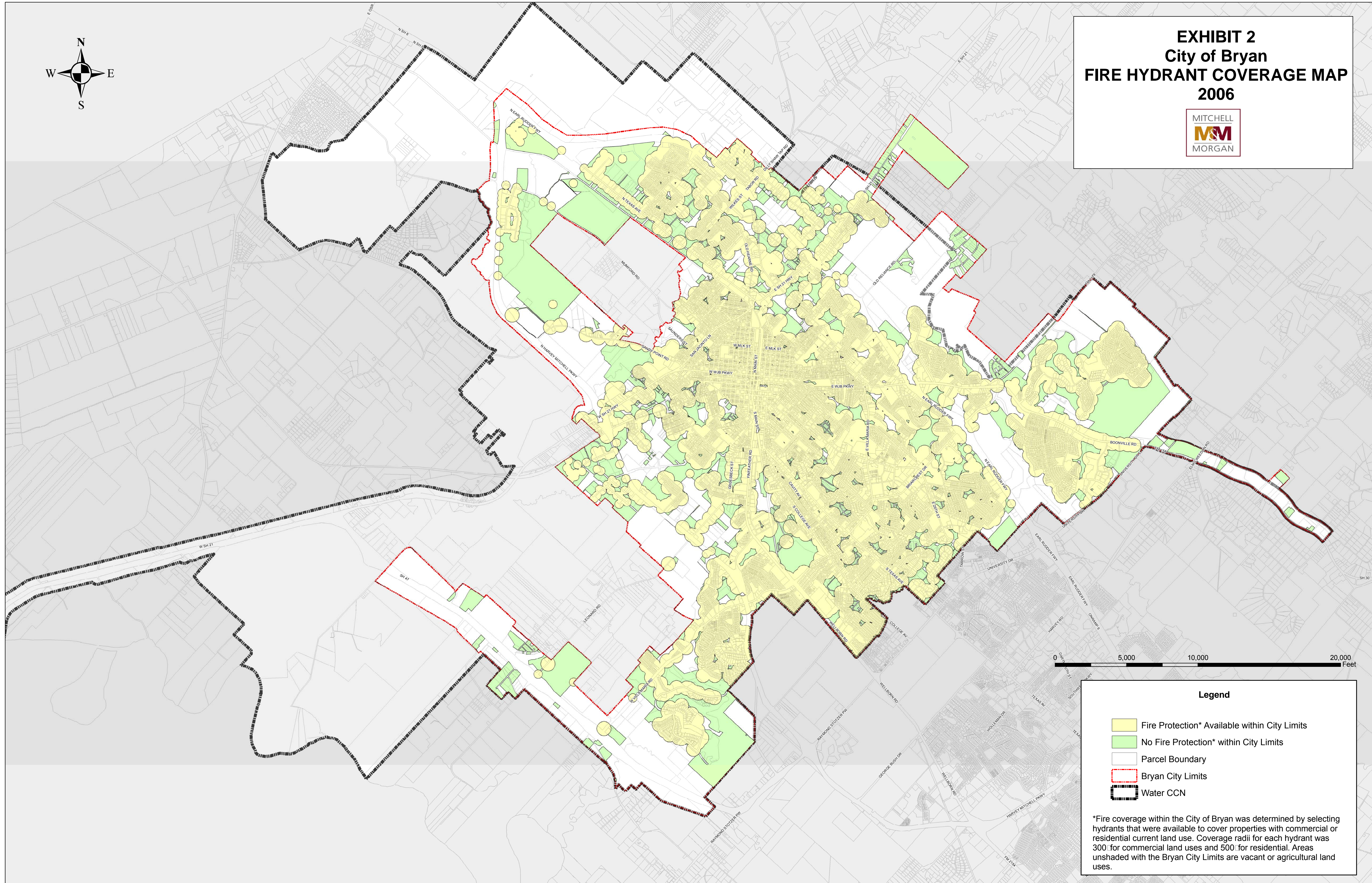


EXHIBIT 2
City of Bryan
FIRE HYDRANT COVERAGE MAP
2006

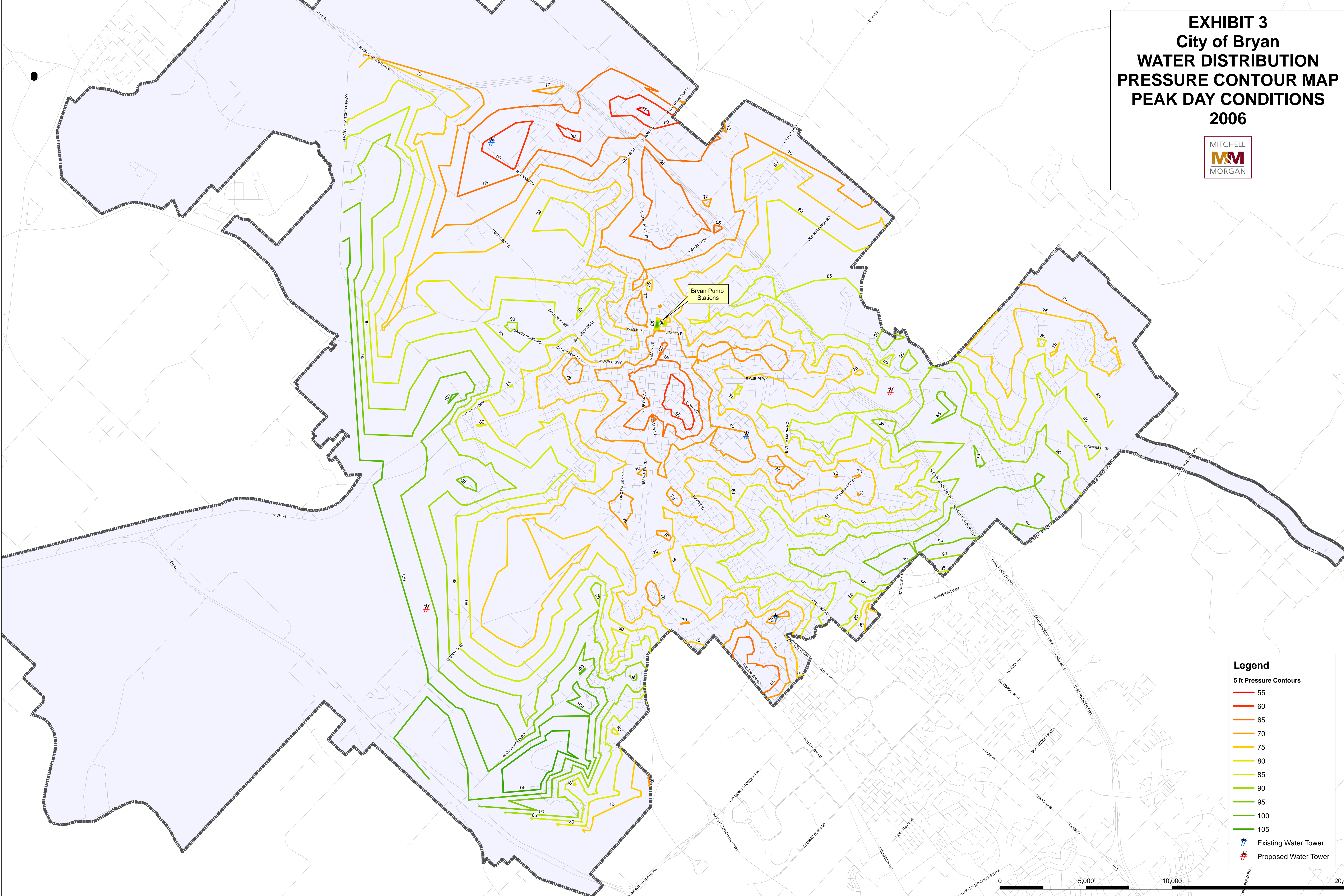


Legend

- Fire Protection* Available within City Limits
- No Fire Protection* within City Limits
- Parcel Boundary
- Bryan City Limits
- Water CCN

*Fire coverage within the City of Bryan was determined by selecting hydrants that were available to cover properties with commercial or residential current land use. Coverage radii for each hydrant was 300' for commercial land uses and 500' for residential. Areas unshaded with the Bryan City Limits are vacant or agricultural land uses.

EXHIBIT 3
City of Bryan
WATER DISTRIBUTION
PRESSURE CONTOUR MAP
PEAK DAY CONDITIONS
2006



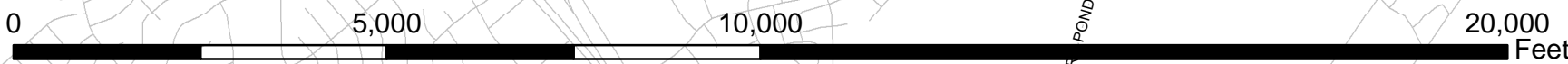
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5 ft Pressure Contours

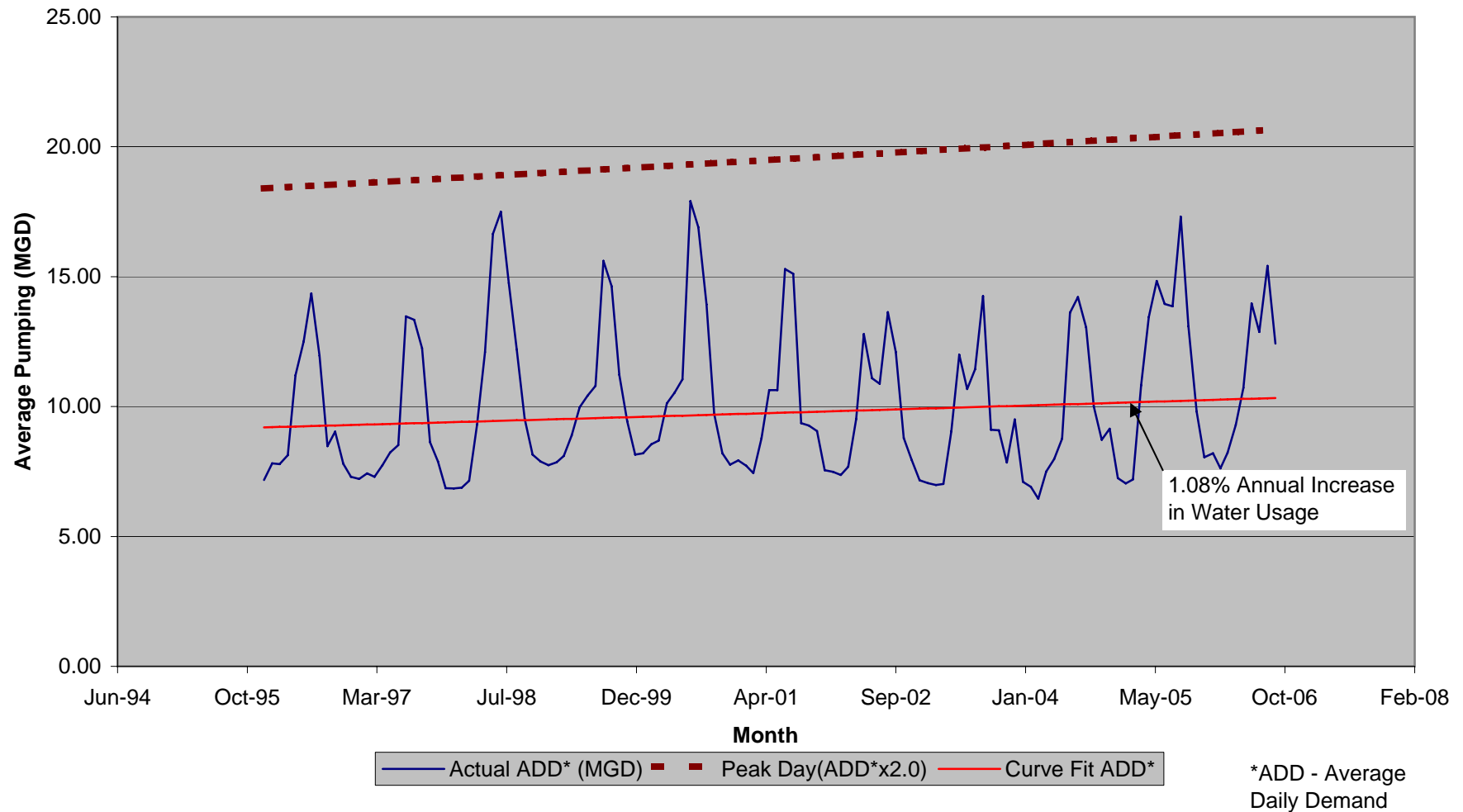
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- 95
- 100
- 105

Existing Water Tower

Proposed Water Tower



Appendix A-1
City of Bryan
2006 Water Master Plan Update
Measured Monthly Average Pumping



Appendix A-2
City of Bryan
2006 Water Master Plan Update
Measured Pumping

MONTH/YR.	Actual ADD* (MGD)	Curve Fit ADD*	Peak Day(ADD*x2.0)
Jan-96	7.17	9.20	18.40
Feb-96	7.82	9.21	18.41
Mar-96	7.78	9.21	18.43
Apr-96	8.13	9.22	18.45
May-96	11.20	9.23	18.46
Jun-96	12.51	9.24	18.48
Jul-96	14.36	9.25	18.50
Aug-96	11.95	9.26	18.51
Sep-96	8.48	9.26	18.53
Oct-96	9.04	9.27	18.55
Nov-96	7.80	9.28	18.56
Dec-96	7.29	9.29	18.58
Jan-97	7.21	9.30	18.60
Feb-97	7.43	9.31	18.61
Mar-97	7.29	9.31	18.63
Apr-97	7.74	9.32	18.65
May-97	8.23	9.33	18.66
Jun-97	8.52	9.34	18.68
Jul-97	13.47	9.35	18.70
Aug-97	13.34	9.36	18.71
Sep-97	12.24	9.37	18.73
Oct-97	8.62	9.37	18.75
Nov-97	7.88	9.38	18.77
Dec-97	6.86	9.39	18.78
Jan-98	6.85	9.40	18.80
Feb-98	6.88	9.41	18.82
Mar-98	7.14	9.42	18.83
Apr-98	9.31	9.43	18.85
May-98	12.10	9.43	18.87
Jun-98	16.65	9.44	18.88
Jul-98	17.50	9.45	18.90
Aug-98	14.75	9.46	18.92
Sep-98	12.20	9.47	18.94
Oct-98	9.53	9.48	18.95
Nov-98	8.15	9.49	18.97
Dec-98	7.88	9.49	18.99
Jan-99	7.75	9.50	19.01
Feb-99	7.85	9.51	19.02
Mar-99	8.10	9.52	19.04
Apr-99	8.89	9.53	19.06
May-99	9.97	9.54	19.07
Jun-99	10.42	9.55	19.09
Jul-99	10.79	9.55	19.11
Aug-99	15.61	9.56	19.13
Sep-99	14.64	9.57	19.14

*ADD - Average Daily Demand

Appendix A-2
City of Bryan
2006 Water Master Plan Update
Measured Pumping

MONTH/YR.	Actual ADD* (MGD)	Curve Fit ADD*	Peak Day(ADD*x2.0)
Oct-99	11.22	9.58	19.16
Nov-99	9.43	9.59	19.18
Dec-99	8.15	9.60	19.20
Jan-00	8.20	9.61	19.21
Feb-00	8.54	9.62	19.23
Mar-00	8.69	9.62	19.25
Apr-00	10.12	9.63	19.27
May-00	10.53	9.64	19.28
Jun-00	11.05	9.65	19.30
Jul-00	17.91	9.66	19.32
Aug-00	16.90	9.67	19.34
Sep-00	13.93	9.68	19.35
Oct-00	9.72	9.69	19.37
Nov-00	8.20	9.69	19.39
Dec-00	7.77	9.70	19.41
Jan-01	7.93	9.71	19.42
Feb-01	7.73	9.72	19.44
Mar-01	7.43	9.73	19.46
Apr-01	8.78	9.74	19.48
May-01	10.63	9.75	19.49
Jun-01	10.64	9.76	19.51
Jul-01	15.30	9.76	19.53
Aug-01	15.11	9.77	19.55
Sep-01	9.36	9.78	19.57
Oct-01	9.27	9.79	19.58
Nov-01	9.06	9.80	19.60
Dec-01	7.55	9.81	19.62
Jan-02	7.49	9.82	19.64
Feb-02	7.37	9.83	19.65
Mar-02	7.68	9.84	19.67
Apr-02	9.51	9.84	19.69
May-02	12.79	9.85	19.71
Jun-02	11.09	9.86	19.73
Jul-02	10.87	9.87	19.74
Aug-02	13.64	9.88	19.76
Sep-02	12.10	9.89	19.78
Oct-02	8.79	9.90	19.80
Nov-02	7.95	9.91	19.82
Dec-02	7.17	9.92	19.83
Jan-03	7.05	9.93	19.85
Feb-03	6.98	9.94	19.87
Mar-03	7.02	9.94	19.89
Apr-03	9.05	9.95	19.91
May-03	11.99	9.96	19.92
Jun-03	10.68	9.97	19.94

*ADD - Average Daily Demand

Appendix A-2
City of Bryan
2006 Water Master Plan Update
Measured Pumping

MONTH/YR.	Actual ADD* (MGD)	Curve Fit ADD*	Peak Day(ADD*x2.0)
Jul-03	11.43	9.98	19.96
Aug-03	14.25	9.99	19.98
Sep-03	9.11	10.00	20.00
Oct-03	9.08	10.01	20.01
Nov-03	7.85	10.02	20.03
Dec-03	9.50	10.03	20.05
Jan-04	7.10	10.04	20.07
Feb-04	6.90	10.04	20.09
Mar-04	6.46	10.05	20.11
Apr-04	7.50	10.06	20.12
May-04	7.97	10.07	20.14
Jun-04	8.76	10.08	20.16
Jul-04	13.61	10.09	20.18
Aug-04	14.21	10.10	20.20
Sep-04	13.04	10.11	20.22
Oct-04	10.00	10.12	20.23
Nov-04	8.72	10.13	20.25
Dec-04	9.15	10.14	20.27
Jan-05	7.25	10.15	20.29
Feb-05	7.04	10.15	20.31
Mar-05	7.20	10.16	20.33
Apr-05	10.82	10.17	20.34
May-05	13.44	10.18	20.36
Jun-05	14.83	10.19	20.38
Jul-05	13.95	10.20	20.40
Aug-05	13.86	10.21	20.42
Sep-05	17.31	10.22	20.44
Oct-05	13.09	10.23	20.46
Nov-05	9.81	10.24	20.47
Dec-05	8.05	10.25	20.49
Jan-06	8.21	10.26	20.51
Feb-06	7.62	10.27	20.53
Mar-06	8.22	10.27	20.55
Apr-06	9.29	10.28	20.57
May-06	10.72	10.29	20.58
Jun-06	13.97	10.30	20.60
Jul-06	12.88	10.31	20.62
Aug-06	15.42	10.32	20.64
Sep-06	12.42	10.33	20.66

*ADD - Average Daily Demand

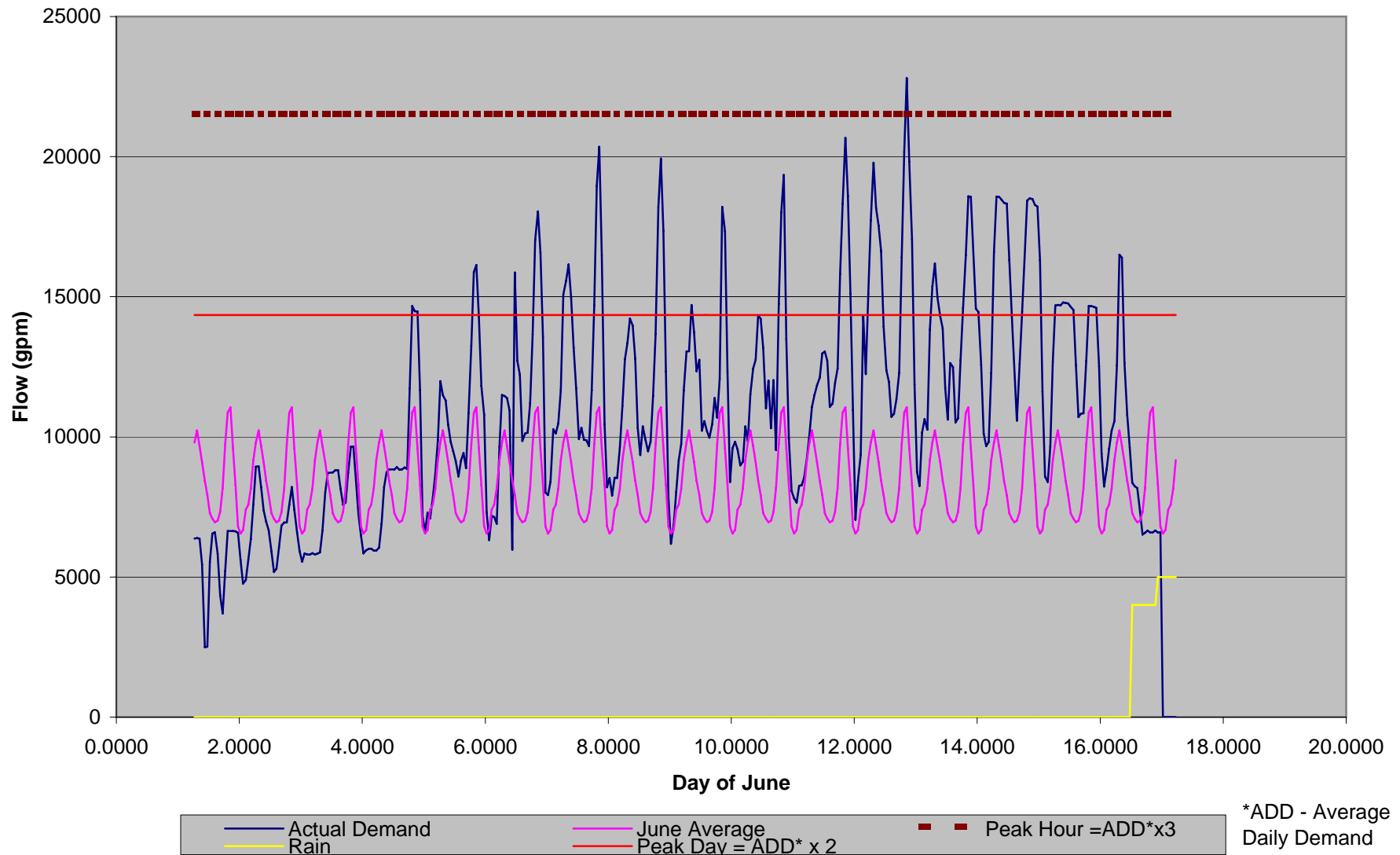
Appendix A-3
City of Bryan
2006 Water Master Plan Update
Water Use Calculations

Historical Demand							Population x 150 gpcd 1.50%	From Pumping Data 1.08%
Year	1.14% Population Growth Rate	Measured Average Daily (MGD)	Per Capita Avg. Usage (gpd)	Measured Peak Monthly (MGD)	(gpm)	Per Capita Peak Usage (gpd)	Growth Rate Est. Average Daily Demand (MGD)	Growth Rate Est. Average Daily Demand (MGD)
2000	65,660	10.96	167	17.91	12439	273	9.85	9.65
2001	66,395	9.90	149	15.30	10623	230	9.96	9.75
2002	67,139	9.70	144	13.64	9471	203	10.07	9.86
2003	67,891	9.50	140	14.25	9899	210	10.18	9.97
2004	68,651	9.45	138	14.21	9868	207	10.30	10.07
2005	69,396	11.31	163	17.31	12021	249	10.41	10.18
2006	70,143	10.97	156	15.42	10708	220	10.52	10.29
Average			151.07			227.51		
		Blue=Measured	Red= Calculated			Green=Estimated		

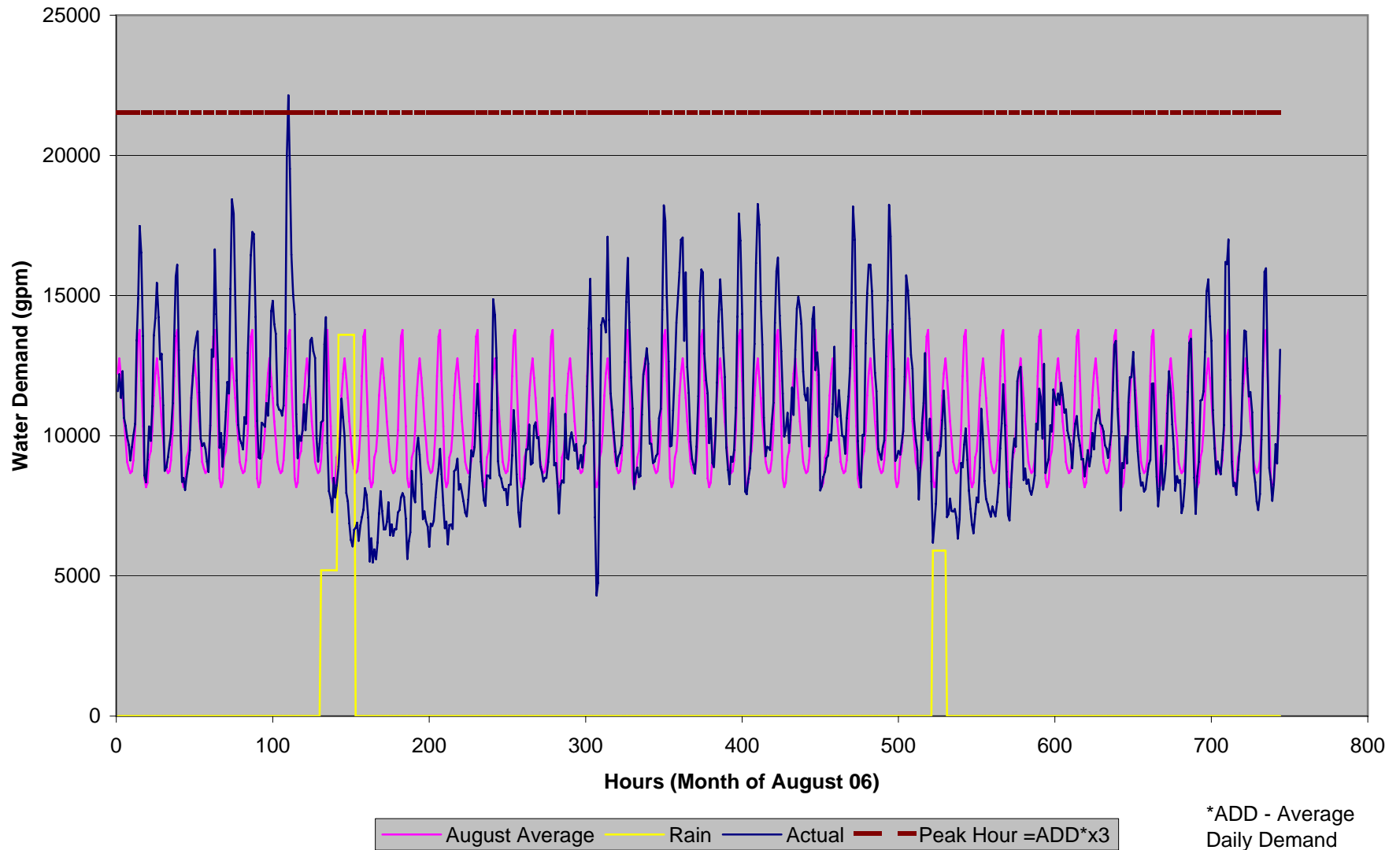
Appendix A-4
City of Bryan
2006 Water Master Plan Update
Water Use Projections

Projected Demand									
Based Upon 1.50% Growth Rate							Based Upon 1.08% Average Annual Water Demand Increase		
Year	1.50% Population	x 150 gpcd Average Daily (MGD)	P.F.= 2 Estimated Peak Day (MGD) (gpm)		P.F.= 3 Estimated Peak Hour (MGD) (gpm)		Average Daily (MGD)	Peak Day (MGD)	Peak Hour (gpm)
2006	70,143	10.52	21.04	14,613	31.56	21,920	10.31	20.62	21,479
2007	71,195	10.68	21.36	14,832	32.04	22,248	10.42	20.84	21,711
2008	72,263	10.84	21.68	15,055	32.52	22,582	10.53	21.07	21,946
2009	73,347	11.00	22.00	15,281	33.01	22,921	10.65	21.30	22,183
2010	74,447	11.17	22.33	15,510	33.50	23,265	10.76	21.53	22,422
2011	75,564	11.33	22.67	15,742	34.00	23,614	10.88	21.76	22,664
2012	76,697	11.50	23.01	15,979	34.51	23,968	11.00	21.99	22,909
2013	77,848	11.68	23.35	16,218	35.03	24,327	11.12	22.23	23,157
2014	79,016	11.85	23.70	16,462	35.56	24,692	11.24	22.47	23,407
2015	80,201	12.03	24.06	16,709	36.09	25,063	11.36	22.71	23,659
2016	81,404	12.21	24.42	16,959	36.63	25,439	11.48	22.96	23,915
2017	82,625	12.39	24.79	17,214	37.18	25,820	11.60	23.21	24,173
2018	83,864	12.58	25.16	17,472	37.74	26,208	11.73	23.46	24,434
2019	85,122	12.77	25.54	17,734	38.30	26,601	11.86	23.71	24,698
2020	86,399	12.96	25.92	18,000	38.88	27,000	11.98	23.97	24,965
2025	93,076	13.96	27.92	19,391	41.88	29,086	12.64	25.29	26,342
2030	100,270	15.04	30.08	20,890	45.12	31,334	13.34	26.68	27,796
2035	108,019	16.20	32.41	22,504	48.61	33,756	14.08	28.16	29,330
2040	116,367	17.46	34.91	24,243	52.37	36,365	14.86	29.71	30,948
2045	125,360	18.80	37.61	26,117	56.41	39,175	15.67	31.35	32,656
2050	135,049	20.26	40.51	28,135	60.77	42,203	16.54	33.08	34,458
2055	145,486	21.82	43.65	30,310	65.47	45,464	17.45	34.90	36,359
2060	156,729	23.51	47.02	32,652	70.53	48,978	18.42	36.83	38,365

Appendix A-5
City of Bryan
2006 Water Master Plan Update
August 2006 Water Demand



Appendix A-6
City of Bryan
2006 Water Master Plan Update
August 2006 Water Demand



Appendix B-1
City of Bryan
2006 Water Master Plan Update
Calibration Data

FLOW HYDRANT ID	TIME OF DAY & DATE	LIST WHICH PUMPS ARE ON	LIST THE TOTAL PUMPING RATE OF SYSTEM, GPM	Pumping per Data Sheets	WATER LEVEL IN N. TEXAS TOWER	N. Texas Tower from Data Sheets	WATER LEVEL IN LUZA ST. TOWER	Luza Tower from Data Sheets	WATER LEVEL IN ROYAL ST. TOWER	Royal Tower from Data Sheets	Data Check	STATIC HYDRANT ID	STATIC HYDRANT STATIC PRESSURE, PSI	Min. Roughness=85	Min. Roughness=90	Min. Roughness=95	Min. Roughness=100	STATIC HYDRANT RESIDUAL PRESSURE, PSI	Min. Roughness=85	Min. Roughness=90	Min. Roughness=95	Min. Roughness=100	FLOW HYDRANT STATIC PRESSURE, PSI	PITOT READING ON FLOW HYDRANT	Min. Roughness=85	Min. Roughness=90	Min. Roughness=95	Min. Roughness=100	FLOW HYDRANT FLOW (GPM)	HYDRANT TYPE	HYDRANT ON WHAT SIZE WATERLINE	HOW LONG WAS HYDRANT OPEN?	MANF. DATE	Adjustme nt to Demand Rate	Hourly Demand	Demand Factor (Actual Demand / Average Day Demand)	N.Texas Tank Elev	Royal Tank Elev	Luza Tank Elev	
O14-003-FH	11/10/2006 13:00	9	6785	6799.6	78	76.3	81.1	81.1	88	88.0	-2%	O14-004-FH	98	89.72	89.81	89.89	89.95	97	76.68	77.43	78.06	78.61	102	75	94.97	95.06	95.14	95.2	1455	Darling B-62	8	4	1986	97.00	6360.2	0.884901	509.3	510.39	513	
O12-003-FH	11/10/2006 13:36	9	6785	6772.0	78	75.9	81.1	81.2	88	88.1	-3%	O13-016-FH	105	101.49	101.56	101.62	101.66	100	95.71	96.26	96.73	97.13	101	77	95.43	95.5	95.56	95.6	1475	Mueller Centurion	12	5	1985	122.92	6380.2	0.887678	509.3	510.39	513	
O12-006-FH	11/10/2006 14:07	9	6785	6736.5	78	75.6	81.1	81.4	88	88.2	-3%	O12-007-FH	100	88.64	88.71	88.76	88.8	80	80.69	81.5	82.19	82.78	98	63	93.37	93.44	93.5	93.54	1325	Darling B-62	6	4	1977	88.33	6383.7	0.888166	509.3	510.39	513	
N11-042-FH	11/10/2006 14:50	9	6785	6670.2	75.6	75.7	81.8	82.0	88.6	88.7	-1%	O12-043-FH	85	81.42	81.44	81.46	81.45	80	79.19	79.37	79.52	79.65	85	63	89.63	89.61	89.59	89.56	1325	Kennedy (Darling B-84-B)	20	4	1981	88.33	6336.8	0.881639	508.46	510.63	513	
O10-055-FH	11/13/2006 11:18	9	7888	7761.8	68.8	69.3	82.1	82.2	90	90.1	-1%	O10-056-FH	70	68.69	68.55	68.41	68.25	55	67.74	67.64	67.55	67.45	70	43	64.89	64.75	64.62	64.45	1100	Darling B-62	8	4		73.33	6870.6	0.955913	506.08	510.74	514	
O11-007-FH	11/13/2006 11:50	9	7838	7790.4	68.8	69.7	82.1	83.0	90.8	91.0	2%	P11-024-FH	90	78.51	78.5	78.5	78.5	86	78.39	78.38	78.36	78.36	80	35	77.38	77.36	77.34	77.32	1000	Mueller	8	3	1954	50.00	6868.2	0.955576	506.08	510.74	514	
O11-042-FH	11/13/2006 13:20	9	5800	5938.3	67	69.7	83	82.8	90.5	90.4	6%	O11-044-FH	83	79.5	79.53	79.55	79.57	81	77.18	77.39	77.57	77.75	76	53	77.55	77.58	77.6	77.62	1225	Mueller	12	3	1958	61.25	6464.2	0.899366	505.45	511.05	514	
N11-021-FH	11/13/2006 13:41	9	5800	5933.8	67	69.7	83	82.4	90.5	90.0	5%	N11-022-FH	78	74.06				45	71.83				70	37	71.3				1033	Darling B-62	8	4	1982	68.87	6244.9	0.86886	505.45	511.05	514	
O08-007-FH	11/13/2006 14:26	9	5861	5965.2	69.5	69.7	82.5	82.2	89.1	89.5	2%	O08-018-FH	83	83.31	83.29	83.27	83.25	79	75.56	76.19	76.73	77.2	99	75	97.81	97.8	97.78	97.76	1455	Darling B-62	12	4	1984	97.00	5979.6	0.83194	506.33	510.88	513	
P08-022-FH	11/13/2006 14:51	9	5861	5995.6	69.5	69.8	82.5	82.3	89.1	89.4	3%	P08-023-FH	98	87.62	87.6	87.57	87.54	81	82.15	82.55	82.89	83.18	93	70	92.01	91.98	91.95	91.92	1405	Darling B-62	12	3	1984	70.25	5909.6	0.822199	506.33	510.88	513	
Q09-006-FH	11/15/2006 12:33	9	6246	6322.8	77.5	75.7	82.8	82.9	89.4	89.5	-1%	P09-003-FH	90	86.78				82	65.83				85	50	76.34				1190	Mueller	6	5	1981	99.17	5270.9	0.733346	509.13	510.98	513	
Q09-003-FH	11/15/2006 12:58	9	6246	6309.3	75.3	75.8	82	83.5	88.9	89.9	5%	Q09-010-FH	85	76.33	76.26	76.19	76.11	82	73.87	73.89	73.91	73.92	86	65	79.96	79.86	79.78	79.68	1350	Darling B-62	12	4	1984	90.00	5146.4	0.716025	508.36	510.7	513	
P09-018-FH	11/15/2006 12:58	9	6287	6309.3	75.9	75.8	83.7	83.5	90	89.9	0%	P09-013-FH	82	74.73	74.65	74.57	74.48	80	71.62	71.79	71.94	72.05	84	33	81.16	81.07	81	80.9	960	Mueller	6	5	1955	80.00	5146.4	0.716025	508.57	511.3	514	
P09-033-FH	11/15/2006 13:20	9	6299	5984.2	76.3	75.9	84.3	84.1	90	90.4	-6%	P09-032-FH	78	77.39	77.3	77.22	77.12	76	73.89	74.08	74.25	74.39	75	57	72.59	72.5	72.42	72.32	1275	Darling B-62	12	4	1979	85.00	5069.3	0.705293	508.71	511.51	514	
P10-013-FH	11/16/2006 13:11	9	6802	6832.7	73.1	73.1	78.8	78.6	86.3	86.3	0%	P10-009-FH	77	58.12				62	56.47				71	25	63.85				63.81	840	Darling B-62	6	5		70.00	6392.5	0.889387	507.59	509.58	512
P10-038-FH	11/16/2006 13:35	9	6805	6839.1	72.7	72.8	78.9	78.8	86.4	86.4	0%	P10-039-FH	85	84.48	84.49	84.49	84.49	70	66.29	68.09	69.62	70.94	88	47	80.79	80.8	80.79	80.79	1160	Mueller	6	4	1956	77.33	6345.5	0.882849	507.45	509.62	512	
P10-066-FH	11/16/2006 14:00	9	6927	6848.2	72.6	72.4	78.4	78.9	86.4	86.4	-1%	Q10-061-FH	83	77.14	77.13	77.12	77.11	81	75.5	75.63	75.74		80	60	78.61	78.59	78.58		1300	Darling B-62	12	6	1981	130.00	6300.9	0.876647	507.41	509.44	512	
Q10-015-FH	11/16/2006 14:30	9	6813	6811.6	72.5	72.5	79.6	79.8	86.5	86.8	1%	Q10-012-FH	80	71.94			71.64	75	70.19				73	55	71.07			70.77	1250	Mueller	6	4	1974	83.33	6190.1	0.86123	507.38	509.86	512	
Q10-041-FH	11/16/2006 14:57	9	6805	6787.2	72.6	72.6	80.2	80.4	86.9	87.1	0%	Q10-042-FH	90	83.94				70	24.46				89	43	84.59				1100	Mueller	6	4	1948	73.33	6116.2	0.850952	507.41	510.07	512	
Q11-030-FH	11/17/2006 8:46	9	6083	6606.2	75.3	75.3	78.8	78.8	87.7	87.4	8%	Q10-057-FH	82	80.55				63	33.85				88	47	84.23				1160	Mueller	6	3	1988	58.00	6507.6	0.905401	508.36	509.58	513	
Q10-028-FH	11/17/2006 9:16	9	7170	6751.4	74.9	75.1	78.9	78.9	87.4	87.5	-6%	Q10-027-FH	80	74.21	74.14	74.08	74.01	78	71.07	71.28	71.45	71.59	76	60	74.48	74.4	74.32	74.23	1300	Darling B-62	12	5		108.33	6482.1	0.901856	508.22	509.62	513	
R10-037-FH	11/17/2006 9:40	9	6678	6941.5	75	74.9	79.2	79.0	87.6	87.5	3%	R10-036-FH	80	77.1	77.06	77.02	76.97	75	73.18	73.46	73.69	73.89	80	65	74.13	74.09	74.05	74	1350	Mueller	12	4	1984	90.00	6466.7	0.899708	508.25	509.72	513	
K08-012-FH	11/17/2006 9:47	9	7210	6989.0	75.4	74.9	79.1	79.0	87.5	87.5	-4%	K08-003-FH	80	73.02				79	72.56	72.61			70	40	66.9				1060	Darling B-84-B	10	5	1995	88.33	6462.8	0.899171	508.39	509.69	513	
N10-057-FH	11/17/2006 10:15	9	7275	7120.5	75.1	74.7	79.2	79.3	87.7	87.7	-3%	N10-056-FH	78	77.14				72	75.46				78	57	70.55				1275	Mueller	18	4	1986	85.00	6447.2	0.897002	508.29	509.72	513	
R10-019-FH	11/17/2006 10:22	9	7218	7123.5	74.4	74.8	79.4	79.5	87.6	87.8	-1%	R10-018-FH	80	76.04	76.02	76.01	75.97	78	71.71	71.94	72.13	72.29	80	47	74.31	74.29	74.27	74.24	1150	Darling B-84-B	8	5	2004	95.83	6442.7	0.896376	508.04	509.79	513	
N09-040-FH	11/17/2006 10:38	9	7239	7126.5	74.5	74.8	79.5	79.6	88	87.9	-1%	N09-049-FH	79	77.8	77.69	77.6	77.47	70	74.71	74.82	74.92	75	83	60	82.96	82.86	82.76	82.64	1300	Mueller	12	5	1948	108.33	6438.2	0.895751	508.08	509.83	513	
N09-009-FH	11/17/2006 11:06	9	7198	7128.9	74.3	74.9	79.9	80.1	88.1	88.1	0%	R09-003-FH	82	81.97				80	69.77				72.56	100	70	84.55			1405	Darling B-62	12	5	1988	117.08	6410.4	0.891886	508.01	509.97	513	
R10-058-FH	11/17/2006 11:08	9	7153	7122.4	74.3	74.9	80.1	80.2	88.2	88.2	0%	R10-059-FH	80	76.33	76.34	76.35	76.36	75	67.34	67.9	68.41	68.86	80	55	76.98	76.98	76.98	76.98	1250	Darling B-84-B	8	3	1999	62.50	6382.4	0.887986	508.01	510.04	513	
O09-055-FH	11/17/2006 11:30	9	7190	7096.5	73.9	74.7	80.4	80.7	88.3	88.5	0%	O09-016-FH	81	73.09	72.99	72.9	72.79	79	69.94	70.08	70.2	70.3	75	55	74.53	74.44	74.35	74.23	1250	Darling B-62	12	5	1979	104.17	6270.3	0.872386	507.87	510.14	513	
S09-045-FH	11/17/2006 11:34	9	7037	7096.5	74.9	74.7	80.7	80.7	88.4	88.5	1%	S09-044-FH	92	88.9				85	51.69				95	70	94.1				1405	Mueller	8	5	1981	117.08	6270.3	0.872386	508.22	510.25	513	
R09-009-FH	11/17/2006 12:04	9	7068	7057.7	74.2	74.6	81.9	81.6	89.1	88.9	0%	R09-008-FH	80	75.09			74.75	78	73.34	73.32			73	63	73.6				1325	Darling B-84-B	24	5	2004	110.42	6086.7	0.846849	507.97	510.67	513	
O09-036-FH	11/17/2006 13:38	9	6368	6501.8	74.4	74.1	84.3	84.3	91.2	90.9	1%	O09-032-FH	80	79.9			79.68	79	75.38				81	60	75.42															

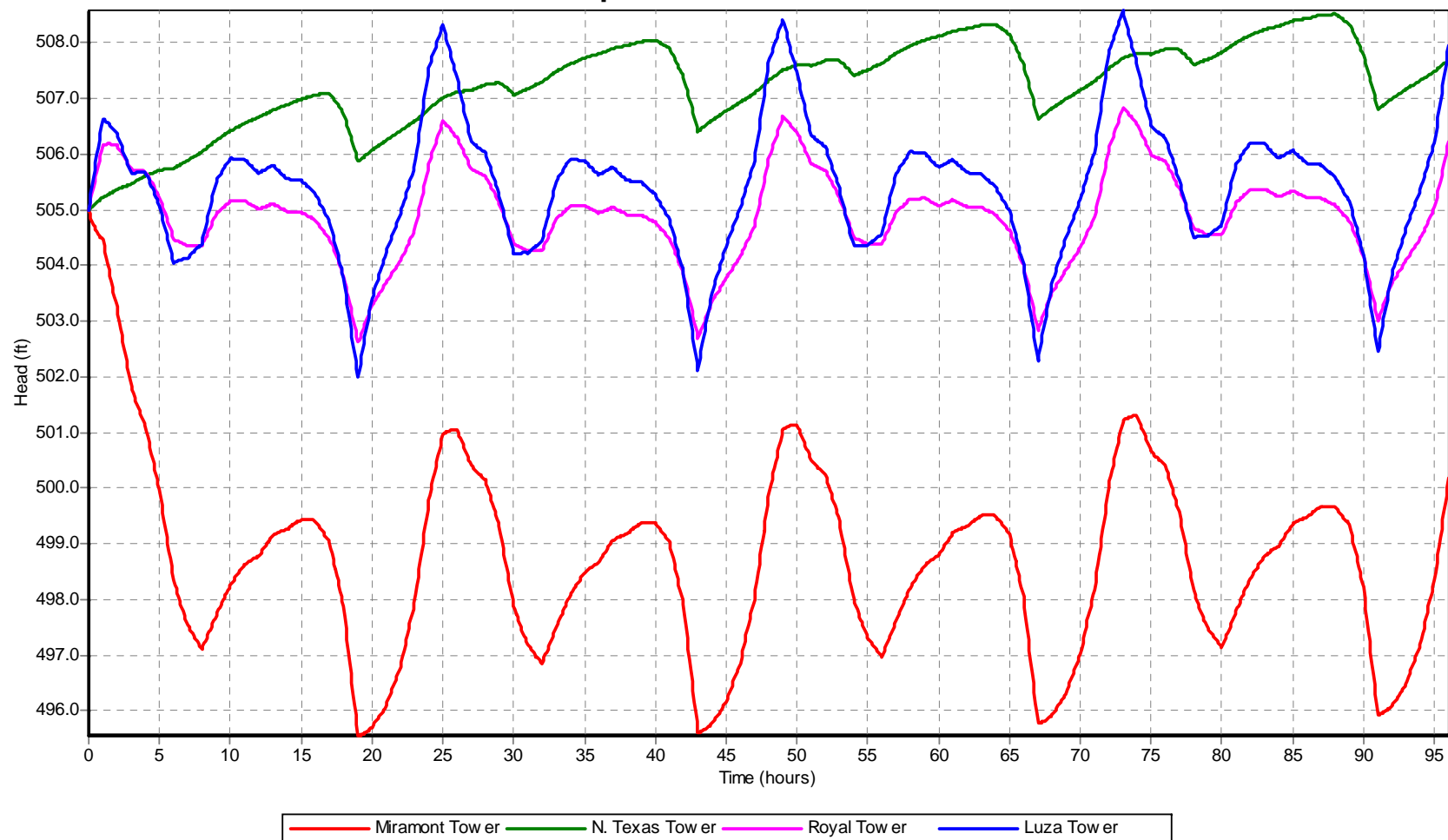
Appendix C-1
City of Bryan
2006 Water Master Plan Update
Review of Recommended System Improvements

2002 Water Master Plan ID Number	Category	Description	Additional Description	Quantity	Units	2002 Unit Cost	2002 Cost	2002 Cost inc. Eng & Contingency	Status	M&M 2006 Recommendation	2006 Cost
5.1 - 6	Capacity Improvement	Boring of Hwy158	Table 6-1 East Bryan	200	LF	\$400	\$80,000	\$120,000	Alternate Completed	Completed	
5.2 - 2	Capacity Improvement	6-inch from W Briar Gate to E. Briar Gate	Table 6-2 Improvements for 500 gpm Fire Flow	1,000	LF	\$80	\$80,000	\$120,000	Alternate Completed	Completed	
5.2-21	Capacity Improvement	12-inch from Red River to Trophy Dr.	Table 6-4 Improvements for 1000 gpm Fire Flow	2100	LF	\$80	\$168,000	\$252,000	Alternate Completed	Completed	
5.1 - 2	Capacity Improvement	12-inch at Sue Haswell Park	Table 6-1 Miscellaneous Capacity Improvements	1,600	LF	\$100	\$160,000	\$240,000	Completed	Completed	
5.2 - 1	Capacity Improvement	12-inch Heatherwood to Forest Wood	Table 6-2 Improvements for 500 gpm Fire Flow	225	LF	\$100	\$22,500	\$33,750	Completed	Completed	
5.2 -4	Capacity Improvement	8-inch Line in Patton from Scanian to Eisenhower	Table 6-2 Improvements for 500 gpm Fire Flow	950	LF	\$80	\$76,000	\$114,000	Completed	Completed	
5.2-12B	Capacity Improvement	6-inch in Forestwood to Verde to Wedgewood	Table 6-3 Improvements for 750 gpm Fire Flow	320	LF	\$80	\$25,600	\$38,400	Completed	Completed	
5.2-14	Capacity Improvement	8-inch in Cole from Waco to Reynolds	Table 6-3 Improvements for 750 gpm Fire Flow	700	LF	\$80	\$56,000	\$84,000	Completed	Completed	
5.2 - 16 B	Capacity Improvement	6-inch line in Tatum	Table 6-4 Improvements for 1000 gpm Fire Flow	200	LF	\$80	\$16,000	\$24,000	Completed	Completed	
5.2-18	Capacity Improvement	12-inch in FinFeather from Eden to Palasota	Table 6-4 Improvements for 1000 gpm Fire Flow	750	LF	\$3,500	\$3,500	\$5,250	Completed	Completed	
5.2 - 19B	Capacity Improvement	12-inch in Finfeather from Ashford Hills to Villa Maria	Table 6-4 Improvements for 1000 gpm Fire Flow	2500	LF	\$80	\$160,000	\$240,000	Completed	Completed	
5.2-23	Capacity Improvement	8-inch line Park from Rosemary to Briar Oaks	Table 6-4 Improvements for 1000 gpm Fire Flow	3500	LF	\$80	\$280,000	\$420,000	Under Design	Completed	
5.2-15 B	Capacity Improvement	8-inch in Dean	Table 6-4 Improvements for 1000 gpm Fire Flow	1500	LF	\$80	\$120,000	\$180,000	Partially Completed	Completed	
5.1 - 1	Capacity Improvement	8-inch line Baker and 30th Street	Table 6-1 Miscellaneous Capacity Improvements	1,350	LF	\$80	\$108,000	\$162,000	Not-Completed	Recommended - High Priority	\$197,640.00
5.1 - 3	Capacity Improvement	12-inch line in Coulter Drive	Table 6-1 Miscellaneous Capacity Improvements	600	LF	\$100	\$60,000	\$90,000	Not-Completed	Not Recommended	\$0.00
5.1 - 4	Capacity Improvement	12-inch line in Bradley Drive	Table 6-1 Miscellaneous Capacity Improvements	1,500	LF	\$100	\$150,000	\$225,000	Not-Completed	Not Recommended	\$0.00
5.1 - 4.1	Capacity Improvement	St. Joseph Lines	Table 6-1 Miscellaneous Capacity Improvements	3,000	LF	\$100	\$300,000	\$450,000		Location Unknown/No Data Provided	\$549,000.00
5.1 - 4.2	Capacity Improvement	Miscellaneous Items					\$77,800	\$116,700		Location Unknown/No Data Provided	\$142,374.00
5.1 - 5	Capacity Improvement	24-inch from Boonville Road to FM 1179 along Hwy 6	Table 6-1 East Bryan	8,000	LF	\$160	\$1,280,000	\$1,920,000	Not-Completed	Alternate Recommended- High Priority	\$872,000.00
5.1 - 5	Capacity Improvement	Boring of Hwy 1179	Table 6-1 East Bryan	200	LF	\$400	\$80,000	\$120,000	Not-Completed	Recommended - High Priority	\$80,000.00
5.1 - 6	Capacity Improvement	18-inch to FM 1179 from FM 158	Table 6-1 East Bryan	8400	LF	\$140	\$1,176,000	\$1,764,000	Not-Completed	Not Recommended	\$0.00
5.1 -6	Capacity Improvement	1.0 MG Elevated Storage Tank	Table 6-1 East Bryan	1	LS		\$1,250,000	\$1,875,000	Not-Completed	Alternate Recommended- High Priority	\$2,000,000.00
5.1 - 6	Capacity Improvement	18-inch to Elevated Storage Tank	Table 6-1 East Bryan	1,500	LF	\$140	\$210,000	\$315,000	Not-Completed	Recommended - High Priority	\$335,200.00
5.1 - 6	Capacity Improvement	12-inch, Hwy 1179 to Nottingham Forest Subdivision	Table 6-1 East Bryan	3,500	LF	\$100	\$350,000	\$525,000	Not-Completed	Recommended - Med Priority	\$566,280.00
5.1 - 6.1	Capacity Improvement	Miscellaneous Items					\$442,600	\$663,900		Location Unknown/No Data Provided	\$809,958.00
5.1 - 7	Capacity Improvement	24-inch from Woodville Rd to Hwy 21 along Hwy 6	Table 6-1 North Bryan	13,000	LF	\$160	\$2,080,000	\$3,120,000	Not-Completed	Alternate Recommended- High Priority	\$1,803.20
5.1 - 7	Capacity Improvement	Boring of Highway 6	Table 6-1 North Bryan	300	LF	\$400	\$120,000	\$180,000	Not-Completed	Recommended - High Priority	\$240,000.00
5.1 - 7	Capacity Improvement	Boring of FM 974	Table 6-1 North Bryan	120	LF	\$400	\$48,000	\$72,000	Not-Completed	Recommended - High Priority	\$80,000.00
5.1 - 7.1	Capacity Improvement	Miscellaneous Items	Table 6-1 North Bryan				\$224,800	\$337,200		Location Unknown/No Data Provided	\$411,384.00
5.2 - 1.1	Capacity Improvement	Add FH's Texas Ave between Highland and Mitchell	Table 6-2 Improvements for 500 gpm Fire Flow	2	LF	\$3,000	\$6,000	\$9,000		Location Unknown/No Data Provided	\$10,980.00
5.2 - 3	Capacity Improvement	6-inch from Country Club to 29th Street	Table 6-2 Improvements for 500 gpm Fire Flow	670	LF	\$80	\$53,600	\$80,400	Not-Completed	Recommended - High Priority	\$98,088.00
5.2-5A	Capacity Improvement	8-inch line in Lightfoot to Teton	Table 6-3 Improvements for 750 gpm Fire Flow	1,200	LF	\$100	\$120,000	\$180,000	Not-Completed	Recommended - High Priority	\$219,600.00
5.2-5B	Capacity Improvement	8-inch line in Old Hearne Rd	Table 6-3 Improvements for 750 gpm Fire Flow	1,000	LF	\$80	\$80,000	\$120,000	Not-Completed	Recommended - High Priority	\$146,400.00
5.2-6	Capacity Improvement	8-inch line in Yaupon	Table 6-3 Improvements for 750 gpm Fire Flow	600	LF	\$80	\$48,000	\$72,000	Not-Completed	Recommended - High Priority	\$87,840.00
5.2-7	Capacity Improvement	6-inch in Washington	Table 6-3 Improvements for 750 gpm Fire Flow	200	LF	\$80	\$16,000	\$24,000	Not-Completed	Not Recommended	\$0.00
5.2-8A	Capacity Improvement	8-inch line in Suncrest	Table 6-3 Improvements for 750 gpm Fire Flow	1,600	LF	\$80	\$128,000	\$192,000	Not-Completed	Recommended - High Priority	\$234,240.00
5.2-8B	Capacity Improvement	6-inch line Cottenwood, Cedar to Bamboo	Table 6-3 Improvements for 750 gpm Fire Flow	600	LF	\$80	\$48,000	\$72,000	Not-Completed	Recommended - High Priority	\$87,840.00
5.2-9A	Capacity Improvement	8-inch in Richard, from Beck to Mockingbird	Table 6-3 Improvements for 750 gpm Fire Flow	700	LF	\$80	\$56,000	\$84,000	Not-Completed	Recommended - High Priority	\$102,480.00
5.2-9B	Capacity Improvement	8-inch in Richard, from Mockingbird to Thomas	Table 6-3 Improvements for 750 gpm Fire Flow	500	LF	\$80	\$40,000	\$60,000	Not-Completed	Recommended - High Priority	\$73,200.00
5.2-10	Capacity Improvement	6-inch line in 25th st. extend to Luza	Table 6-3 Improvements for 750 gpm Fire Flow	220	LF	\$80	\$17,600	\$26,400	Not-Completed	Not Recommended (1150 gpm)	\$0.00
5.2-11	Capacity Improvement	8-inch line from Manchester to Hwy 6	Table 6-3 Improvements for 750 gpm Fire Flow	1,150	LF	\$80	\$92,000	\$138,000	Not-Completed	Not Recommended (1150 gpm)	\$0.00
5.2-12A	Capacity Improvement	6-inch form Manorwood to Forest Bend	Table 6-3 Improvements for 750 gpm Fire Flow	620	LF	\$80	\$49,600	\$74,400	Not-Completed	Recommended - High Priority	\$90,768.00
5.2-13	Capacity Improvement	12-inch in Kent from Hwy 1179 to Barak Lane	Table 6-3 Improvements for 750 gpm Fire Flow	550	LF	\$100	\$55,000	\$82,500	Not-Completed	Not Recommended	\$0.00
5.2-15 A	Capacity Improvement	8-inch in Hunters, Reno and Nevada	Table 6-4 Improvements for 1000 gpm Fire Flow	3000	LF	\$100	\$300,000	\$450,000	Not-Completed	Recommended - High Priority	\$549,000.00
5.2 - 16A	Capacity Improvement	6-inch line in Fannin	Table 6-4 Improvements for 1000 gpm Fire Flow	400	LF	\$80	\$32,000	\$48,000	Not-Completed	Recommended - High Priority	\$58,560.00
5.2-17	Capacity Improvement	Connect 6-inch to 12 at Richard and Rodedale	Table 6-4 Improvements for 1000 gpm Fire Flow	1	LS	\$3,500	\$3,500	\$5,250	Not-Completed	Recommended - High Priority	\$6,405.00
5.2 - 19A	Capacity Improvement	6-inch from forest Bend to Popular	Table 6-4 Improvements for 1000 gpm Fire Flow	500	LF	\$80	\$40,000	\$60,000	Not-Completed	Not Recommended (1036 gpm)	\$0.00
5.2-20	Capacity Improvement	Connect 8-inch in Dellwood to 12-inch in Texas	Table 6-4 Improvements for 1000 gpm Fire Flow	1	LS	\$3,500	\$3,500	\$5,250	Not-Completed	Not Recommended	\$0.00
5.2-22A	Capacity Improvement	Connect 6-inch from Lazy Lane to Mary Lake	Table 6-4 Improvements for 1000 gpm Fire Flow	850	LF	\$80	\$68,000	\$102,000	Not-Completed	Recommended - High Priority	\$124,440.00
5.2-22B	Capacity Improvement	6-inch line in Carter Creek PI	Table 6-4 Improvements for 1000 gpm Fire Flow	600	LF	\$80	\$48,000	\$72,000	Not-Completed	Recommended - High Priority	\$87,840.00
										Subtotal	\$8,263,320.20
1	System Expansion	12-inch line in Hwy 21 West	Table 6-5 SW Bryan 2005 Anticipated Improvements	24,000	LF	\$100	\$2,400,000	\$3,600,000	Not-Completed	Alternate Recommended - Low Priority	\$2,080,000.00
2	System Expansion	12-inch line in Hwy 47	Table 6-5 SW Bryan 2005 Anticipated Improvements	20,000	LF	\$100	\$2,000,000	\$3,000,000	Not-Completed	Alternate Recommended - Low Priority	\$3,402,464.00
3	System Expansion	24-inch line from Harvey Mitchell to FM1179	Table 6-5 SW Bryan 2005 Anticipated Improvements	15,000	LF	\$160	\$2,400,000	\$3,600,000	Completed	Completed	
4	System Expansion	12-inch from Briarcrest and Hwy 6 to 29th Street	Table 6-5 East Bryan 2005 Anticipated Improvements	10,000	LF	\$100	\$1,000,000	\$1,500,000	Not-Completed	Recommended - Med Priority	\$531,544.00

Appendix C-1 City of Bryan 2006 Water Master Plan Update Review of Recommended System Improvements											
2002 Water Master Plan ID Number	Category	Description	Additional Description	Quantity	Units	2002 Unit Cost	2002 Cost	2002 Cost inc. Eng & Contingency	Status	M&M 2006 Recommendation	2006 Cost
5	System Expansion	12-inch from Tabor Rd. to Old Reliance	Table 6-5 North Bryan 2005 Anticipated Improvements	20,000	LF	\$100	\$2,000,000	\$3,000,000	Not-Completed	Alternate Recommended - Low Priority	\$403,416.00
6	System Expansion	12-inch in Old Reliance Road	Table 6-5 North Bryan 2005 Anticipated Improvements	10,000	LF	\$100	\$1,000,000	\$1,500,000	Partially completed w/ HS	Completed	
7	System Expansion	8-inch loop from Mumford to Sandy Point	Table 6-5 FM 2818 2005 Anticipated Improvements	12,500	LF	\$80	\$1,000,000	\$1,500,000	Not-Completed	Alternate Recommended - Low Priority	\$1,192,152.00
8	System Expansion	18-inch line in Leonard Road to Hwy 47	Table 6-6 SW Bryan 2010 Anticipated Improvements	15,000	LF	\$140	\$2,100,000	\$3,150,000	Completed	Completed	
9	System Expansion	16-inch loop from FM1179 to FM2818	Table 6-6 SW Bryan 2010 Anticipated Improvements	12,500	LF	\$125	\$1,562,500	\$2,343,750	Partially-Completed	Alternate Recommended - Low Priority	\$987,272.00
10	System Expansion	1.0 MG Elevated Storage Tank	Table 6-6 SW Bryan 2010 Anticipated Improvements	1	LS		\$1,250,000	\$1,875,000	Not-Completed	Alternate Recommended - Low Priority	\$2,000,000.00
11	System Expansion	18-inch line to Elevated Storage Tank	Table 6-6 SW Bryan 2010 Anticipated Improvements	750	LF	\$140	\$105,000	\$157,500	Not-Completed	Alternate Recommended - Low Priority	\$843,600.00
12	System Expansion	12-inch from Briarcrest and Hwy 6 to Copperfield Dr.	Table 6-6 East Bryan 2010 Anticipated Improvements	9,000	LF	\$100	\$900,000	\$1,350,000	Not-Completed	Recommended - Med Priority	\$686,400.00
13	System Expansion	12-inch , Hwy 158 to Back of Copperfield Subd.	Table 6-6 East Bryan 2010 Anticipated Improvements	5,000	LF	\$100	\$500,000	\$750,000	Not-Completed	Recommended - Med Priority	\$1,048,320.00
14	System Expansion	12-inch in Hwy 21	Table 6-6 North Bryan 2010 Anticipated Improvements	5,000	LF	\$100	\$500,000	\$750,000	Not-Completed	Recommended - Low Priority	\$703,456.00
15	System Expansion	12-inch in Future Roadway, between Hwy 21 &	Table 6-6 North Bryan 2010 Anticipated Improvements	17,500	LF	\$100	\$1,750,000	\$2,625,000	Not-Completed	Not Recommended	
16	System Expansion	18-inch loop in Woodville	Table 6-6 NW Bryan 2010 Anticipated Improvements	5,000	LF	\$140	\$700,000	\$1,050,000	Not-Completed	Not Recommended	
17	System Expansion	16-inch loop from Woodville to Tabor Road	Table 6-6 NW Bryan 2010 Anticipated Improvements	5,000	LF	\$125	\$625,000	\$937,500	Not-Completed	Not Recommended	
18	System Expansion	12-inch loop from 2818 to Woodville Road	Table 6-6 NW Bryan 2010 Anticipated Improvements	24,000	LF	\$100	\$2,400,000	\$3,600,000	Not-Completed	Alternate Recommended - Low Priority	\$3,109,600.00
19	System Expansion	12-inch Line to OSR/D&S Water	Table 6-6 NW Bryan 2010 Anticipated Improvements	9,000	LF	\$100	\$900,000	\$1,350,000	Not-Completed	Not Recommended	
20	System Expansion	12-inch line in Sandy Point Road to D&S Water	Table 6-6 SW Bryan 2020 Anticipated Improvements	5,000	LF	\$100	\$500,000	\$750,000	Not-Completed	Not Recommended	
21	System Expansion	12-inch line	Table 6-6 N Bryan 2020 Anticipated Improvements	5,800	LF	\$100	\$580,000	\$870,000	Not-Completed	Not Recommended	
M&M1	Capacity Improvement	Pump for High Service Pump Station							New	Recommended - High Priority	\$180,000.00
M&M2	Capacity Improvement	Elevation Valve for N. Texas 1 MG Tank							New	Recommended - High Priority	\$200,000.00
M&M-A	System Expansion	18" Line along 2818 from SH 6 to SH 21							New	Recommended - Low Priority	\$4,545,000.00
										Subtotal	\$21,913,224.00
										Total	\$30,176,544.20

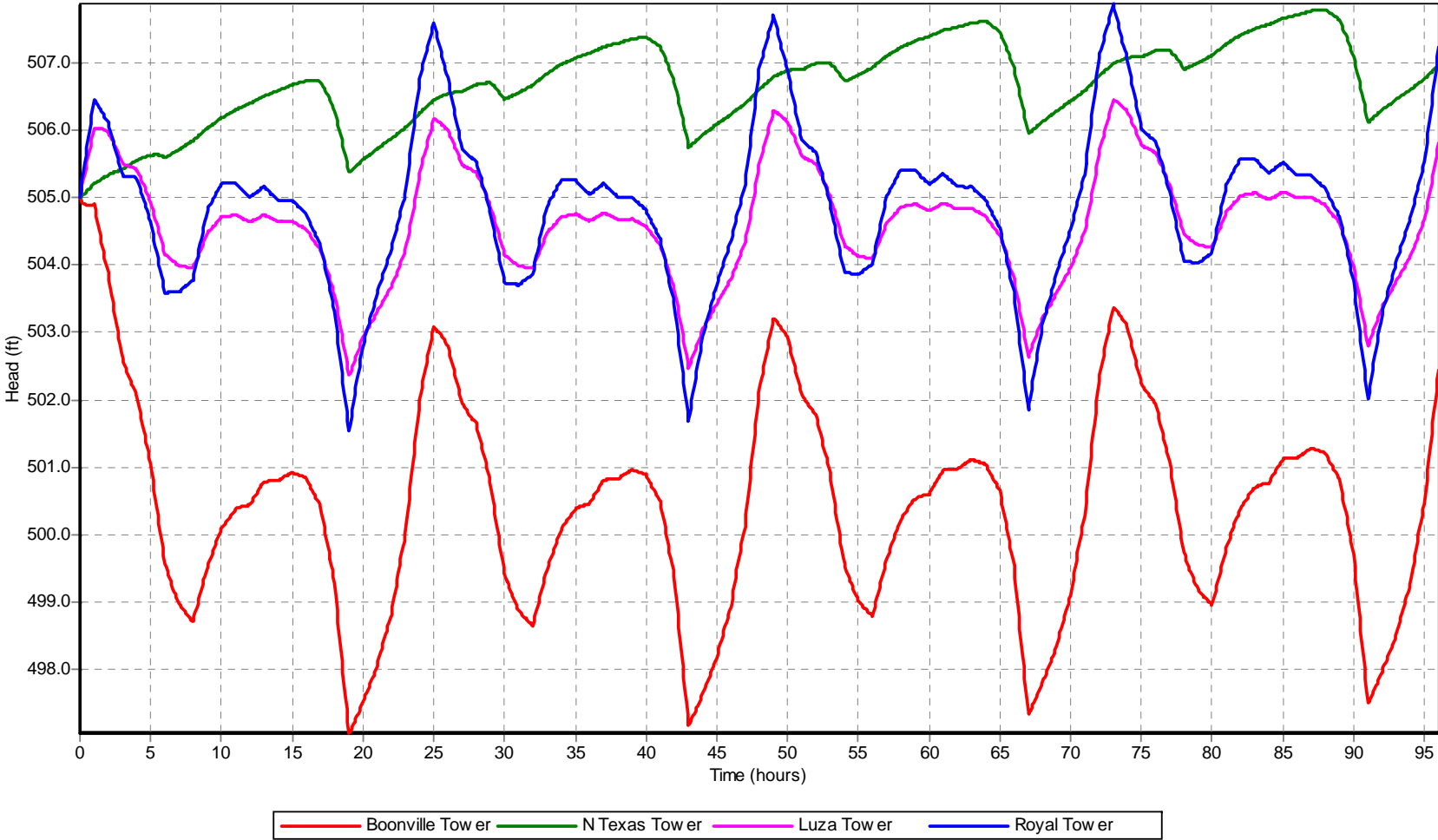
Appendix C-2

Operation of Towers



Appendix C-3

Operation of Towers



Appendix C-4
City of Bryan
2006 Water Master Plan Update
System Curve - Bryan Water System

